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Commonwealth of the Philippines
Department of Agriculture and Commerce
BUREAU OF MINES
Manila

INFORMATION CIRCULAR No. 1

PLACER OPERATIONS OF NORTH MINDANAO MINING CO. SURIGAO, MINDANAO

By

W. F. BOERICKE and N. N. LIM

MANILA
BUREAU OF PRINTING
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COMMONWEALTH OF THE PHILIPPINES
DEPARTMENT OF AGRICULTURE AND COMMERCE
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PLACER OPERATIONS OF NORTH MINDANAO MINING CO., SURIGAO, MINDANAO [*]

W. F. Boericke[†] and N. N. Lim[‡]

INTRODUCTION

North Mindanao Mining Company has been conducting a hydraulic mining operation in the Province of Surigao, Mindanao, 14 kilometers southwesterly of the municipality of Surigao. About 24,000 cubic yards per month are sluiced by customary hydraulic mining methods, employing two No. 2 giants for piping. The gravel is washed through a string of eleven 12-feet sluice boxes equipped with Hungarian riffles, set on a 6.2 per cent grade. No quicksilver is used in the boxes. A $\frac{5}{8}$ cubic yard diesel-powered caterpillar crane is used for handling and removing boulders and stumps. The total operating cost per yard of gravel washed has been about 17 centavos (8.5 cents) before allowances for head office expenses.

The property is located 7 kilometers from the Provincial Highway at Kilometer 7, and from this point the mine is accessible through a carabao trail. All supplies and food must be packed in by cargadores or carabaos, and heavy rains often make transportation difficult. Surigao is the headquarters for mail and supplies. Miners live at barrios in the camp or nearby.

The gold-bearing gravel occupies a relatively flat ridge between Cansuran and Tugunan Rivers, and extends generally in a north-south direction. The surface is densely covered with tropical vegetation, making travel difficult except where trails have been cut. The Cansuran ridge has an elevation of about 450 feet and drops off sharply east and west at the rims of the plateau, thus making tailings disposal relatively easy.

ACKNOWLEDGMENTS

Acknowledgment is made to Mr. Aaron Parry, Superintendent, and his assistants at the mine, for coöperation in obtaining the data for this paper, and to Mr. Earle W. Bedford, Consulting Engineer for the property.

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[*] The Bureau of Mines will welcome the reprinting of this paper, provided the following footnote acknowledgment is used "Reprinted from Philippine Bureau of Mines Information Circular No. 1."

[†] Valuation Engineer, Philippine Bureau of Mines, Manila.

[‡] Mining Engineer, Philippine Bureau of Mines, Manila.

HISTORY

Placer mining extends back for many decades in the Surigao Province. The local miners washed the ground with bateas, and drove small tunnels into the bench gravel for prospecting. Indications of these old workings serve as a guide for later testing. It is said that in 1883 an American prospector reported gold on Cansuran creek in a talcose serpentine slate and shale, and, following the American occupation after the Spanish war, numerous prospectors were attracted to the country. Hydraulic mining was started in 1914 but ceased after a year due to water shortage and poor gold recovery. Operations were resumed in 1936 by the present Company and have continued to date.

GEOLOGY

The gravel deposits appear to be the remnants of an ancient auriferous river channel, which was subjected to subsidence and subsequent upheaval and erosion of modern streams. The wide distribution of gold over both valley and ridge suggests the presence of a former great river, the bed of which was at a level corresponding to the present ridge. The subsequent elevation of the land mass, with intrusion of andesites, interfered with the flow and left the gravels to be washed over by the present drainage system. Most of the gravel is andesitic in character and is irregularly distributed across the old channel.

Pratt * questioned the correctness of the theory of an ancient river channel and held from its character and distribution that the gravel could be more satisfactorily accounted for as talus and piedmont deposits from the adjacent mountains which are gold bearing. "The rounding of some of the gold and of the gravel might have resulted from abrasion incident to slide on the local mountain slopes while the sharp, fine gold found in the placers may have come from veins in the schist which forms the bedrock over the placer itself."

Pratt's comments were made before the present development of the property, which tend to confirm the theory of an ancient river channel. The varying appearance of the gold recovered in different sections of the hydrauliced area suggests that more than one stream was existent. Distribution of the

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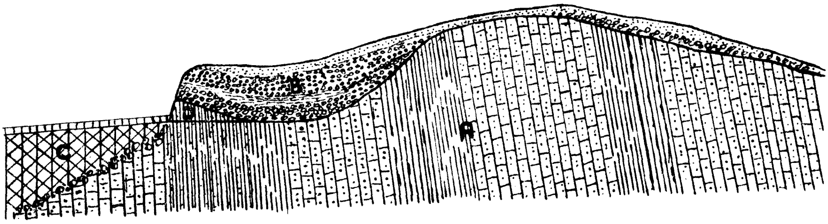
* Wallace E. Pratt, formerly with the Division of Mines, Bureau of Science, Manila.

gold across the tested area is by no means uniform and it appears that there are three separate pay channels where values are much above the average.

The bedrock is a highly compressed shale or sandstone, greatly fractured and folded, dipping at a steep angle to the east. The channel extends in a general north-south direction, as disclosed by the test pits. The maximum width of the channel between rims exceeds 2,000 feet, and test-pits have indicated over 1,500 feet of workable ground in places. The channel has been tested along its length for 4,200 feet.

The depth from surface to bedrock on the plateau varies from 4 or 5 feet to 40 feet, and will average about 12 feet. The depth actually cut by the giants is considerably in excess of this, as the soft shale is easily cut away in piping. Laterization in some places has proceeded down to the bedrock and gravel may be entirely absent.



A- BEDROCK - SLATE & SANDSTONE
B- GRAVEL - COMPOSING OVERBURDEN, GRAVEL, SHALEY SANDSTONE & GRAVEL.
C- TRESTLE AND SLUICE BOX.
D- EXCESS BEDROCK PIPED.

FIG. I
CROSS SECTION OF GRAVEL

The bedrock has a general slope to the north of 3 feet in 100, and usually shows a local rise toward the center of the channel. See Fig. 1, showing a section across the channel from west to east at crosscut K on the Estanislao claim, where piping is now in progress. Advantage is taken of the bedrock slope in laying out the sluices. Where a local rise intervenes, the bedrock is sluiced away to provide a channel.

Fig. 2 shows the north face of the ground at crosscut K. It will be noted that below the first layer of gravel there is a so-called "brown streak," or false bedrock, then another layer of gravel containing large boulders, then the true bedrock.

Distribution of the gold is irregular, and is not concentrated on the bedrock. It may occur most plentifully in the alluvium above the gravel, or in the gravels themselves. Records of 475 test pits do not permit any generalization as to a particularly favorable horizon for gold deposition. Black sand is present in large amounts.

DISTRIBUTION OF BOULDERS

Boulders are abundant in the gravel and vary in size from a baseball to those weighing several tons. The larger ones materially hamper the hydraulic operations and require removal by mechanical means. A considerable proportion of the boulders, which are typically well rounded and smooth, will exceed 12 inches in diameter. A count of the boulders displayed in a square yard on the north face at crosscut K showed the following:

Size of boulders	Number	Area occupied *Square inches*
16″ × 8″	1	128
+8″	3	24
+4″	9	36
+2″	125	250
	138	438

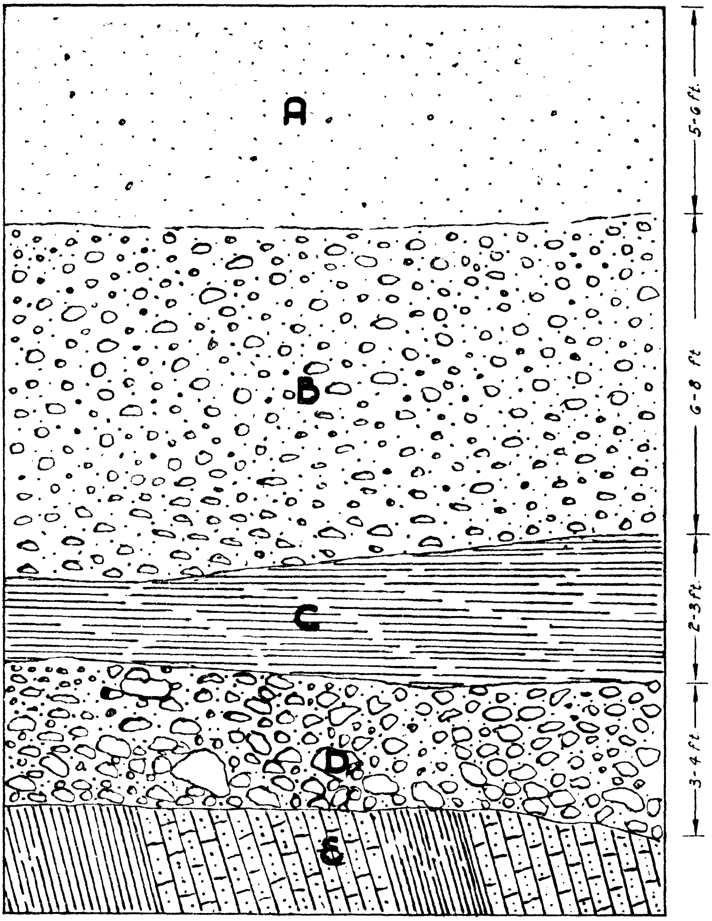
Ground occupied by boulders, 33 per cent.

METHOD OF HANDLING BOULDERS

Wherever possible, boulders are worked through the sluice by hand. The comparatively steep grade of the sluices, 9 inches per 12-foot box, creates a high water velocity, and boulders as large as 10 inches in diameter are sluiced through.

Large boulders and the so-called "brown streak," or false bedrock, are removed by crane. The method formerly used was to construct a high line of wire cable strung across the hydrauliced area, with a carrier by which boulders and stumps were elevated and moved away by a donkey engine. This involved a tremendous amount of labor incident to bringing over the boulders to a point under the high line and seriously hampered piping operations. The only other alternative was straight dragging by cable.

To eliminate these difficulties the company purchased early in 1938 a No. 40 Lorain crane with drag line equipment and this has proven satisfactorily. The crane weighing 18 tons is diesel-powered and rated at 57 H.P., with a 60-foot boom, and full circle rotation. It is equipped with a ¾-cubic yard bucket with



A—Overburden
B—Gravel
C—False bedrock
D—Gravel with boulders
E—Bedrock

FIG. 2

SECTION OF PLACER GROUND

5/8-inch cable, and has a lifting capacity of 11 tons with the boom vertical.

In handling boulders a stone sling is employed, 6 feet square, with iron chains set on 8-inch mesh. The weight of the sling is 250 pounds. A load of 2,200 pounds of boulders can be taken with the boom in extended position. The sling is laid flat on the ground and boulders are barred down or rolled upon it. Two gangs of men and two slings are used. The crane sets on a bench above the pit, picks up the loaded sling, and deposits the boulders in neat rows on the worked-out ground back of the giants.

The cost of operation of the crane for three months has been as follows, exclusive of labor, maintenance, and depreciation:

Crude oil consumed, 530 gallons, at ₱0.257	₱136.45
Mobiloil No. 40, 20 gallons, at ₱1.69	33.80
Lubricating oil No. 3, 7.5 gallons, at ₱2.05	15.43
Grease No. 44 Keystone, 2 lbs., at ₱0.71	4.49
Total	₱190.17
Total hours of operation for crane	398
Cost of operation per hour	₱0.477

Two crane operators are employed, each working 12-hour shifts, but actual operating time is only 4 to 5 hours per day on the average. When the crane is idle, the operators help around the pit if needed. The operators are natives and have attained no little ability in manipulating the crane efficiently.

SAMPLING

All the ground is sampled in a careful manner by test pitting ahead of mining. The area to be tested is surveyed and staked out in rectangular blocks. As the ground is heavily forested, considerable slashing for trails must be done in advance. Blocks are laid out 150 by 75 feet, and pits of about 4 by 4 feet in cross section are sunk to the bedrock at each corner of the rectangle. As the pits rarely exceed 20 feet in depth, there is little difficulty in digging unless water is encountered. A 15-foot shaft can be sunk in three 8-hour shifts, using a portable hand windlass. Shallow shafts are sunk in a day's time.

When excavation is completed the pit is sampled by cutting a section 12 inches square into its side from surface to bedrock. The material for the sample is placed by the sample-cutter into a 5-gallon can setting flush against the wall, hoisted to the surface, and carried by porters to the nearest water for panning. Sampling a 10-foot shaft takes about 3 hours. This obviously involves panning about 1/3 yard of gravel. Panning is done in bateas by native miners who are notably expert in recovering the gold. The testing is supervised by the engineer in charge. A record is kept of the amount of gold encountered per foot of depth by counting number of colors and classifying as to size. Notes are also taken on the character of ground, boulders, water level, etc. No attempt is made to remove a boulder that may project into the channel and interfere with obtaining a true 12-inch section at such a point, but all sand and clay are carefully scraped away from around it.

The total amount of gold obtained by panning the sample is placed in a bottle with the black sand, and subsequently assayed. From the total amount in milligrams the value of the ground per cubic yard is calculated by conventional methods. While a fire assay of the sample is not good practice, as the result gives total gold content, some of which may not be recoverable by placer methods, in this instance no perceptible error appears involved. The approved method of amalgamating the free gold, and subsequently refining it gave practically the same results on check samples. It appears that the black sand in the small amount embraced in the sample did not carry gold values.

The gold particles are classified by the panners as fine, medium, and coarse colors. Fineness of the gold is 800. By actual count, it requires 49 fine colors, for 10 mgms. of value 1.1 cents, if 1,000 fine, or 25 colors for 1 centavo.

Re-sampling of individual test pits in most instances fails to show close checks, but general averages of a group of pits check fairly well. This is probably due to the erratic character of the gold deposition in the gravel which varies within rather wide limits in short distances. The irregular occurrence of boulders, which may cause a greater or lesser quantity of gravel to be taken for panning from a standard cross section of ground, may also be a factor.

COMPARISON OF SAMPLED AND RECOVERED VALUES

The total yardage of a sampled block is obtained from the area of the block and the average depth of the four test pits. The average value per cubic yard for each test pit is known from the sampling, and a weighted average for the block is calculated taking into account the different pit depths. From this figure and the yardage of the block the gross value is obtained in pesos.

The total yardage hydrauliced each month is calculated from surveys of the excavated area, and from the amount of the clean-up the average value per cubic yard washed during the period can be determined.

Based on the actual hydraulicing of the gravel, the gold recovered per cubic yard has exceeded the sampled value by 27 per cent, according to results of 12 months operations during which period 283,900 cubic yards were washed. The total value recovered from this yardage was ₱101,171 indicating an average of ₱0.356 per yard (0.178 cents). The average of the tested blocks in this area was 28 centavos (14 cents) per yard. Similarly, the record of a later period, when 30,449 yards were washed, which showed tested values of 32 centavos per yard, actually gave a recovery of 42.7 centavos per yard, an increase of 30 per cent over sampled value. It also appears that the total cubic yards washed during both of these periods exceeded the calculated yardage of the tested blocks embraced. This latter fact is explained by the increased amount of bedrock hydrauliced, which cuts easily due to its generally soft, shaly nature under the high cutting power of the giants.

Recovery of higher values than were shown in the sampling may be due to occasional bedrock enrichment in crevices not encountered in the test pits, or to enriched channels within the blocks. However, it sometimes happens that recovery may exceed sampled values in placer operations.*

WATER SUPPLY

The water-supply system for the property embraces nearly 18,000 feet of ditches and flumes and brings practically all the drainage of the local water shed to the main reservoir located 250 feet above the site of hydraulic operations. From the reservoir, with a storage capacity of approximately 2,000,000 gallons, the water flows through a reservoir gate to the penstock, thence by a pipe line to the giants. The pipe line consists of 2,037 feet of 20-inch, 14 gauge slip joint welded pipe in 16-foot sections, followed by 1,000 feet of 16-inch, 14 gauge pipe, then two 10-inch pipes to the giants. The total length of pipe line is over 4,000 feet.

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* See I. C. 6961, U. S. Bureau of Mines, "Placer Operations of Humphreys Gold Corporation," where recovered value was 60.9 cents *versus* sampled value of 43.8 cents per yard. Also see I. C. 6846, "Placer Mining Methods of E. T. Fisher Co." where drill hole samples averaged 19 cents while actual recovery was 25 cents per yard.

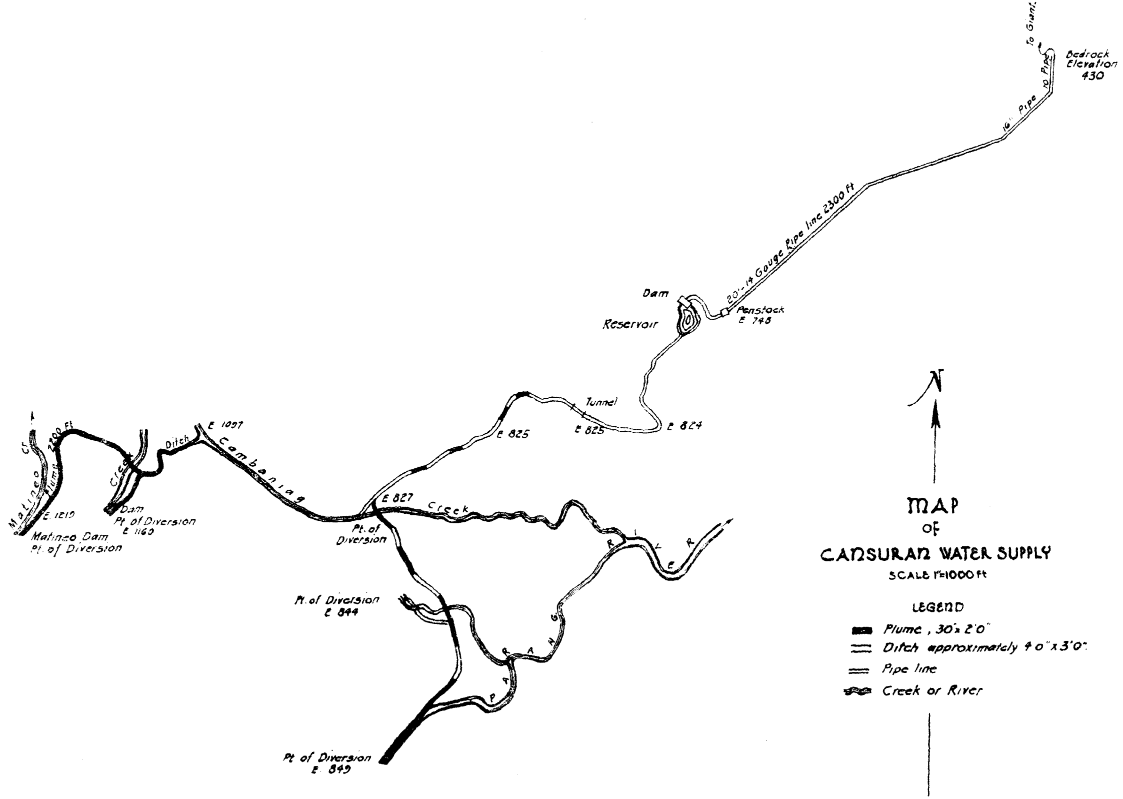
MAP
OF
CANSURAN WATER SUPPLY
SCALE 1"=1000 ft
LEGEND
Plume, 30"x 2'0"
Ditch approximately 4'0"x 3'0"
Pipe line
Creek or River
N
To Giant.
Bedrock Elevation 430
10" Pipe
16" Pipe
20"-14 Gouge Pipe line 2300 ft
Penstock E 748
Dam
Reservoir
Tunnel
E 824
E 825
E 825
E 827
Creek
Pt. of Diversion
RIVER
PARANG
Pt. of Diversion E 844
Pt of Diversion E 849
Cambaniag
E 1097
Ditch
Creek
Dam Pt of Diversion E 1160
Matineo Cr
Flume 2200 Ft
E. 1219
Matineo Dam Pt. of Diversion

FIG 3

Leakage has developed in the pipe line at the joints and welds. Leakage at joints is remedied by driving flat wooden wedges around the joint and binding them with a steel clamp. It is believed, however, that a heavier pipe would be more suitable for the 250-foot head encountered. The pipe line is well anchored along the ground with rock at frequent intervals.

Water is conducted to the reservoir by six flumes, totaling 8,331 feet in length and 9,315 feet of open ditch. There are also two short tunnels. The main trunk ditch, 3,289 feet in length, leads from a point of diversion at Tugunan River to the storage reservoir. The ditch is approximately 4 feet wide and 3 feet deep, rip-rapped and benched on the hillside to prevent material sliding down after heavy rains.

Flumes 3 by 2 feet in cross section are built of native lumber hand-sawed on the property. Apitong resin, boiled with charcoal to thicken, is poured into the cracks, and oakum inserted to make water-tight. Frequent replacement and repairs of trestles are necessary due to termites attack. Two men are constantly employed in repairing flumes and ditches. Fig. 3 shows the general layout of the water-supply system.

The cost of flume construction is low, in comparison with costs in western United States. Details of the construction cost of the Matineo flume, built June 28 to August 31, 1937, follow:

Camp construction	₱40.00
Cutting and pulling poles for trestles:	
Labor	528.00
Supervision	61.00
Grading:	
Labor	48.00
Supervision	5.00
Trestle construction:	
Labor	697.00
Supplies	151.00
Supervision	79.00
Flume construction:	
Labor	277.00
Supplies	971.00
Supervision	32.00
Forestry charge for timber	616.00
Total	₱3,767.00

Cost per foot—₱1.73 ($0.86).

In this instance lumber was cut on the ground, adjacent to the construction, on contract for ₱0.04 per board foot.

RAINFALL *

According to records of the Surigao area, averaged for a period of 30 years, the rainfall is as follows:

Month	Rainfall inches	Rainy days
January	21.9	24
February	14.3	19
March	13.4	20
April	9.9	17
May	6.2	13
June	4.9	12
July	6.5	14
August	4.6	11
September	6.3	13
October	10.4	18
November	16.8	21
December	24.5	24
Total	139.7	206

CUBIC YARDS OF GRAVEL WASHED PER MINERS INCH

Measurements made on water flow at the flume from reservoir gate to penstock, with the gate open for normal piping operations, indicate a flow of approximately 900 miners inches, at a head of 250 feet. A considerable proportion of this flow is lost in pipe leakage and diversion to use of hand miners and it is likely that actual delivery to the giants is not over 700 inches.

Piping is done on three shifts, but is not continuous on account of water shortage. Total piping hours for the 12 months from April 1, 1937 through March, 1938, were 3,452 hours, an average of 10 hours per day of 24 hours for 347 days worked, during which period 277,500 cubic yards were washed.

Duty of a miner's inch of water in hydraulicing is defined as the number of cubic yards of gravel which it can break down and send through the sluice in 24 hours. †

Based on washing an average of 800 cubic yards per 10-hour day the duty per miners inch, assuming 700 inches delivered to the giants, has been 2.6 cubic yards, a normal figure for hydraulic operations elsewhere.

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* From tabulation furnished by Father Miguel Selga, J. S., Director, Weather Bureau.

† I. C. 6787, U. S. Bureau of Mines, "Placer Mining in the United States."

GIANTS

Two No. 2 Hendy giants are in use, with a third held in reserve. A 3-inch nozzle is used on one giant, a 4-inch on the other. The former is used for cutting, and the latter for driving. Each giant has a standard deflector for guiding the stream.

Giants are moved to a new position in the pit about every two days. Moving requires about 2½ hours time. The giants are located initially about 40 to 50 feet from the face to be cut, but piping can be done from as far as 150 feet. Under 250 feet head, the theoretical discharge from the two giants would be 578 miners inches, equivalent to 6,360 gallons per minute. The pipers have been carefully trained in operation of the giants, and there have been no accidents.

PIPING OPERATION

By washing ground at the rate of 25,000 yards per month, with 10 to 20 feet height of bank, about an acre of ground is removed monthly. This necessitates frequent moving of the sluice boxes with new construction of trestle work, and is planned in advance so that there is no delay in piping operations.

When a new area of ground is to be opened up, the trestle work for the new string of sluice boxes is first constructed, extending out on the hillside at right angles to the slope, with the first sluice box set level with the exposed bedrock on the side of the rim, or a few feet below it. A bulkhead is built up around the entrance to the box, and a gate constructed. A giant is set up on the bank and piping commences. As space is opened up, the second giant is moved in, or set above on higher ground driving gravel down to the first giant. In the first instance, the bank attacked is undercut and caved, with the bedrock swept clean of gravel by one giant, while the other does the cutting. The bedrock is generally so soft and cuts so quickly that channels must be filled with rock to prevent their getting below sluice box level.

Boulders of medium size are worked down by hand to where they can be sent through the sluice. The hard layers of silt, or false bedrock, are broken up with bars and removed by the crane, if possible, rather than sluiced away, to avoid introducing clay that might act as a "sluice robber" of the gold. Four men are generally needed in the pit, moving boulders, and keeping the entrance clear at the head of the sluice.

For working at night, lighting is provided by 500-watt headlights set on poles about 10 feet high, back of the giants. These headlights are adjustable, and provide good illumination of the pit. Power is furnished by a 250 volt, 70 amp. D. C. generator connected to a 19-H.P. diesel engine, which also provides electricity for the camp and office. Total lighting equipment at the pit includes four 500-watt, three 200-watt, and five 100-watt lamps. Cost of generated power, including general expense, wages of operator, and fuel oil. is 3.9 centavos per K.W.H.

SLUICE BOX CONSTRUCTION

The standard set of sluice boxes used at this mine consists of eleven 12-foot boxes, 2 feet wide by 3 feet deep, of 2-inch lumber, lined with 1-inch boards. There are no drops between boxes, which are set up end to end. All lumber is hand-sawed from red lauan, and lasts 3 or 4 years. The cost of lumber on contract is 5 centavos per board foot. Frame posts are 3″ × 6″ in size; braces 2″ × 4″. The trestle is made of 6″ × 8″ posts and framing of 3″ to 4″ round trees. While construction is temporary, it is sturdy. Lining boards, made from yacal, last only a few months, due to the hard wear from boulders passing through the sluice. When a pit is worked out beyond economic distance from the sluices, the latter are torn down and the stringers are reused.

GRADE OF SLUICE BOXES

The sluice boxes are set on a uniform grade of 9 inches to the 12-foot box, or 6.2 per cent. This is considerably steeper than average California practice, but steeper grades than this are used in Alaska. It has been found that on a 6 per cent grade the riffles do not pack, while on any less grade, they packed up solidly with black sand. The steep grade also facilitates moving the boulders through the sluices without choking up the boxes. It is also believed that the steep grade aids in the recovery of the fine gold, although no actual tests have been made to determine this. In this connection, W. A. Newman remarks on California practice as follows:*

> Contrary to what might be expected, the recovery of fine gold is oftentimes improved by increasing within reasonable limits the grade of the sluice especially where the gravel contains a large proportion of sands. Where the grade is too light (say 4 inches or less per 12-foot box) the flakey fine gold has a tendency to float over the sand which this light grade has caused to pack on the sluice bottom. The heavier grade and correspondingly increased velocity of water will cause agitation and gold particles will settle to the riffles by virtue of their specific gravity.

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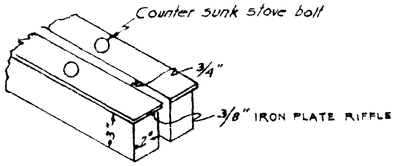
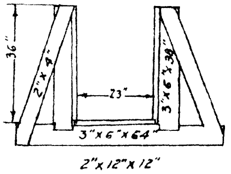
* "Sluice Boxes Must Pay", Eng. & Ming. Journal, Vol. 138, No. 5.

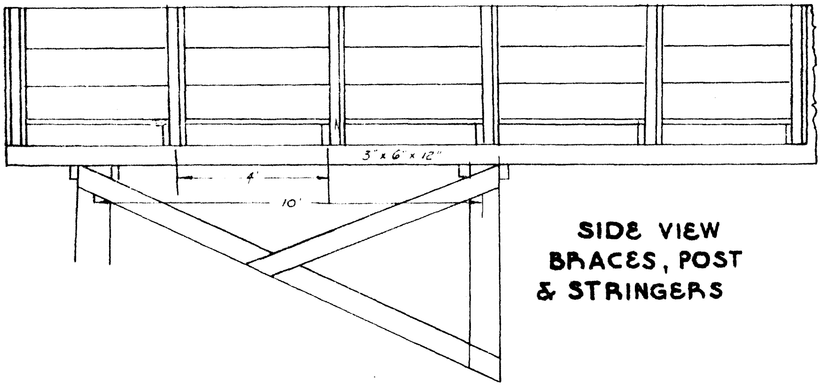


DETAIL OF HUNGARIAN RIFFLE

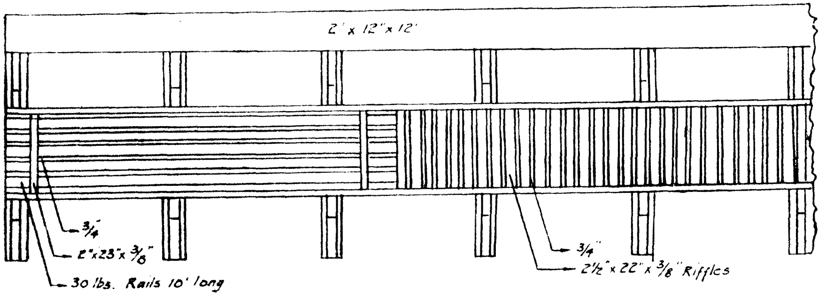
Fig. 4



FRONT VIEW



SIDE VIEW
BRACES, POST
& STRINGERS



TOP VIEW
RAILROAD RAIL AND HUNGARIAN RIFFLES

DESIGN
OF
SLUICE BOXES & CONSTRUCTION
SHOWING RIFFLES

This appears to apply particularly to conditions encountered in the North Mindanao property.

RIFFLES

The first box has five 30-pound rails, 10 feet long, laid lengthwise, and held in place by notched spacers at both ends and in the middle. The rails are spaced ¾-inch apart. By placing the rails longitudinally the boulders get a good start downward on their travel before striking the transverse riffles. The latter are of the Hungarian type, and are made up in sections for easy removal during clean-up. They consist of 2½-inch by ⅜-inch strap iron fastened with stove bolts ⅜-inch by 3½-inch to 2-inch by 3-inch cross pieces of hard yacal. Each section is 4 feet in length and 24 inches in width overall, and is held together by two ½-inch bolts at each end. There are 12 riffles to each section, spaced 1½-inch apart. Each riffle has an overlap of ½-inch on the down side, which creates the necessary boil and agitation for gold saving.

For details of construction of sluice box and riffles, see Fig. 4.

CLEAN-UP

A clean-up is made about twice a month. Work is started by the night shift on the bedrock runways, to the sluice boxes, where it has been found that most of the gold collects. The giants are shut down, and water is led down in pipes in a steady, quiet stream, spreading over the entire area of bedrock to be cleaned. The clean-up crew, 8 in number, start leveling back the ground from the sluice gate for 20 feet or so, sending boulders through the sluice, then shovelling in the fines until the surface of bedrock is clean. The surface is subsequently scraped to remove the fine gold. Quite frequently considerable coarse gold is found in bedrock crevasses.

The day shift starts the regular clean-up. Boards are laid in front of the gate to sluice, shutting off nearly all water flow, and clean-up starts at the front end. The rails in the first box are first pried up and carefully washed free of all fine material. The gold and black sand are washed down the sluice with about ¼-inch of water in the box, and shovelled out into cans. The lining boards are brushed with whisk broom to dislodge fine gold particles. The fine gravel remaining in the box is loosened and worked upward against the water flow, then thrown out, leaving only the black sand behind. Five men are needed in the clean-up, with an overseer.

After the first box is cleaned up, the others are taken in turn down to the end. As is usually the case, by far the greater amount of gold is recovered in the first two or three boxes. No quicksilver is used in the clean-up, and the material in the cans consists entirely of black sand and gold. Clean-up of sluice boxes is completed at noon, and about an hour is needed to replace riffles, when piping operations are resumed.

The cans are carried back to camp, about a quarter mile distant, with ordinary precautions taken to prevent theft. The final clean-up is performed by native girls with bateas, in the use of which they are notably expert. A small concrete pool has been built, around which six girls are seated and pan the black sand. No visible gold, even the finest colors, can be seen in the black sand after they finish, but there appear to be values that may be chemically held, as an assay of the sands shows ₱63.24 per metric ton ($31.62). The gold is dried, weighed, and sent to Manila for shipment to the Mint.

A careful visual examination was made of the cleaned dried gold in an attempt to classify it according to screen size. Colors were classified as very coarse (+3 mm), coarse (1.5-3 mm), medium (0.75–1.5 mm) and fine (–0.75 mm). A tabulation shows:

	Per cent of total
Very coarse	5.8
Coarse	23.4
Medium	35.4
Fine	35.4
	100.0

The percentage of fine gold recovered, in spite of the comparatively steep grade of sluice boxes, appears noteworthy.

TAILINGS DISPOSAL

In general this problem offers no difficulty at this property. As hydraulicing operations take place on high ground that drops sharply on either side of the rim to valleys below, with the land owned by the company, the washed gravel and debris is simply discharged from the last sluice box and accumulates on the hillside. Where the slope is very steep, the water tends to cut back toward the trestle legs and weaken their footing. In this case trees are felled and a debris dam is built up in the channel to hold the tailings and prevent further cutting.

LABOR

Sixty men are employed at the mine, including a superintendent, members of the office staff, and operatives. These are classified as follows, with wage rates indicated:

	Number	Wage rate
Foreman	3	1 at ₱125 a month 2 at ₱82.50 a month
Capatazes	3	₱45.00 a month
Pipers	9	₱1.25 per day
Crane operators	2	₱50.00 per month
Laborers	15	₱0.85 per day
Reservoir tender	1	₱37.50 per month
Ditch walker	2	₱0.75 per day
Miscellaneous laborers	6	₱0.75 per day
Carpenters	2	1 at ₱67.00 per month 1 at ₱37.50 per month
Bodegueros	2	₱32.00 per month
Surveyor	1	₱120.00 per month
Mechanic	1	₱77.50 per month
Saw filer	1	₱37.50 per month
Engine operator	1	₱42.50 per month
Timekeeper	1	42.50 per month
Office force	2	₱52.50 per month
Apprentice	1	₱57.50 per month
Cook	1	₱30.00 per month
Policemen	2	1 at ₱57.50 per month 1 at ₱37.50 per month
Messengers	2	₱32.50 per month
Superintendent	1	Not disclosed
Accountant	1	Not disclosed

Labor conditions are good, and labor turnover has been very low. Many of the men have been continuously on the job for over 2 years.

OPERATING COSTS

[For March, 1938. 30 days work. 25,087 cubic yards washed]

	Total	Per yard
Labor:		
Boulder removal	₱800.00	₱0.033
Piping	252.00	0.010
Pipe moving	209.00	0.008
Ditch and reservoir maintenance	218.00	0.008
Other mine labor	332.00	0.013
Barrio and bodega maintenance	73.00	0.003
Mine office and mess	210.00	0.008
Miscellaneous employees	190.00	0.007
Superintendence, engineering, accounting	870.00	0.035
Total labor	₱3,154.00	₱0.125
Supplies:		
Fuel oil	₱112.00	₱0.004
Mine operating supplies	256.00	0.011
Mine general supplies	203.00	0.008
Total	₱571.00	₱0.023
Total labor and supplies	₱3,725.00	₱0.148

No allowance is made in this cost for depreciation or depletion, taxes, or administrative expense outside of the mine.

For a period of 14 months, during which 331,360 cubic yards were washed, the total mine operating cost was ₱57,595 or ₱0.173 per yard. During this period 2,261 ounces of gold were recovered, including 259 ounces purchased from local miners working small sections of the ground by hand methods.

The reduction in operating costs for the March, 1938, period reflects better operating conditions due to introduction of the crane.

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